

Appendix C for KSCR221200250201

Calibration Certificate

Object	Apply	No	Model	SN	Calibration Date	Due date of calibration
Dipole	☐	1	CLA150	4025	2021/04/26	2024/04/25
	☐	2	D450V3	1103	2021/04/21	2024/04/20
	☐	3	D750V3	1188	2022/03/29	2025/03/28
	☐	4	D835V2	4d114	2022/03/31	2025/03/30
	☐	5	D900V2	1d079	2022/06/07	2025/06/06
	☐	6	D1800V2	2d170	2022/03/31	2025/03/30
	☐	7	D1900V2	5d136	2022/06/07	2025/06/06
	☐	8	D2000V2	1041	2022/06/06	2025/06/05
	☐	9	D2300V2	1096	2022/03/31	2025/03/30
	☒	10	D2450V2	817	2022/04/01	2025/03/31
	☐	11	D2600V2	1158	2022/03/31	2025/03/30
	☐	12	D5GHzV2	1095	2022/06/01	2025/05/31
DAE	☒	13	DAE4	1245	2022/05/30	2023/05/29
Probe	☒	14	EX3DV4	7767	2022/10/28	2023/10/27



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1 Dipole

1.1 CLA150 - SN 4025

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland		S Schweizerischer Kalibrierdienst Service suisse d'étalonnage C Servizio svizzero di taratura S Swiss Calibration Service	
Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates		Accreditation No.: SCS 0108	
Client: SGS-CN (Auden)		Certificate No: CLA150-4025_Apr21	
CALIBRATION CERTIFICATE			
Object: CLA150 - SN: 4025			
Calibration procedure(s): QA CAL-15-v9 Calibration Procedure for SAR Validation Sources below 700 MHz			
Calibration date: April 26, 2021			
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature $22 \pm 3^\circ\text{C}$ and humidity $< 70\%$.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 10475	09-Apr-21 (No. 217-03201/03202)	Apr-22
Power sensor NRP Z91	SN: 10344	09-Apr-21 (No. 217-03201)	Apr-22
Power sensor NRP Z91	SN: 10345	09-Apr-21 (No. 217-03202)	Apr-22
Reference 20 dB Attenuator	SN: C22862 (203)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310692 / 00367	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX30N4	SN: 3877	30-Dec-20 (No. EX3-3877_Dec20)	Dec-21
ENEA	SN: 684	26-Jan-20 (No. D458-684_Jan20)	Jun-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter S44135	SN: G841203074	06-Apr-18 (in house check Jun-20)	In house check Jun-22
Power sensor E4113A	SN: MY41490807	06-Apr-18 (in house check Jun-20)	In house check Jun-22
Power sensor E4113A	SN: 000100210	06-Apr-18 (in house check Jun-20)	In house check Jun-22
RF generator HP 8440D	SN: US484001709	04-Aug-19 (in house check Jun-20)	In house check Jun-22
Network Analyser Agilent E8363A	SN: US41000477	31-Mar-14 (in house check Oct-20)	In house check Oct-21
Calibrated by:	Name: Jeffrey Katzman	Function: Laboratory Technician	Signature:
Approved by:	Name: Kaja Polovic	Function: Technical Manager	Signature:
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Issued: April 26, 2021			
Certificate No: CLA150-4025_Apr21		Page 1 of 6	

Measurement Conditions	
DASY system configuration, as far as not given on page 1:	
DASY Version	V52.10.4
Extrapolation	Advanced Extrapolation
Phantom	ELIA Flat Phantom
EUT Positioning	Touch Position
Zoom Scan Resolution	$dx, dy = 4.0 \text{ mm}$, $dz = 1.4 \text{ mm}$
Frequency	$150 \text{ MHz} \pm 1 \text{ MHz}$
Graded Ratio	1.4 (Z direction)

Head TSL parameters	
The following parameters and calculations were applied:	
Nominal Head TSL parameters	22.0°C
Measured Head TSL parameters	$(22.0 \pm 0.2)^\circ\text{C}$
Head TSL temperature change during test	$< 0.5^\circ\text{C}$
Permittivity	52.3
Conductivity	0.75 mho/m
Permittivity	$51.1 \pm 6\%$
Conductivity	$0.75 \text{ mho/m} \pm 6\%$

SAR result with Head TSL	
SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition
SAR measured	1 W input power
SAR for nominal Head TSL parameters	normalized to 1W
SAR	3.90 W/kg
SAR	$3.88 \text{ W/kg} \pm 19.4\% \text{ (k=2)}$
SAR averaged over 10 cm^3 (10 g) of Head TSL	condition
SAR measured	1 W input power
SAR for nominal Head TSL parameters	normalized to 1W
SAR	2.60 W/kg
SAR	$2.59 \text{ W/kg} \pm 18.0\% \text{ (k=2)}$

Appendix (Additional assessments outside the scope of SCS 0108)	
Antenna Parameters with Head TSL	
Impedance, transformed to feed point	$47.9 \Omega \pm 1.5 \Omega$
Return Loss	-31.4 dB
Additional EUT Data	
Manufactured by	SPLEAG

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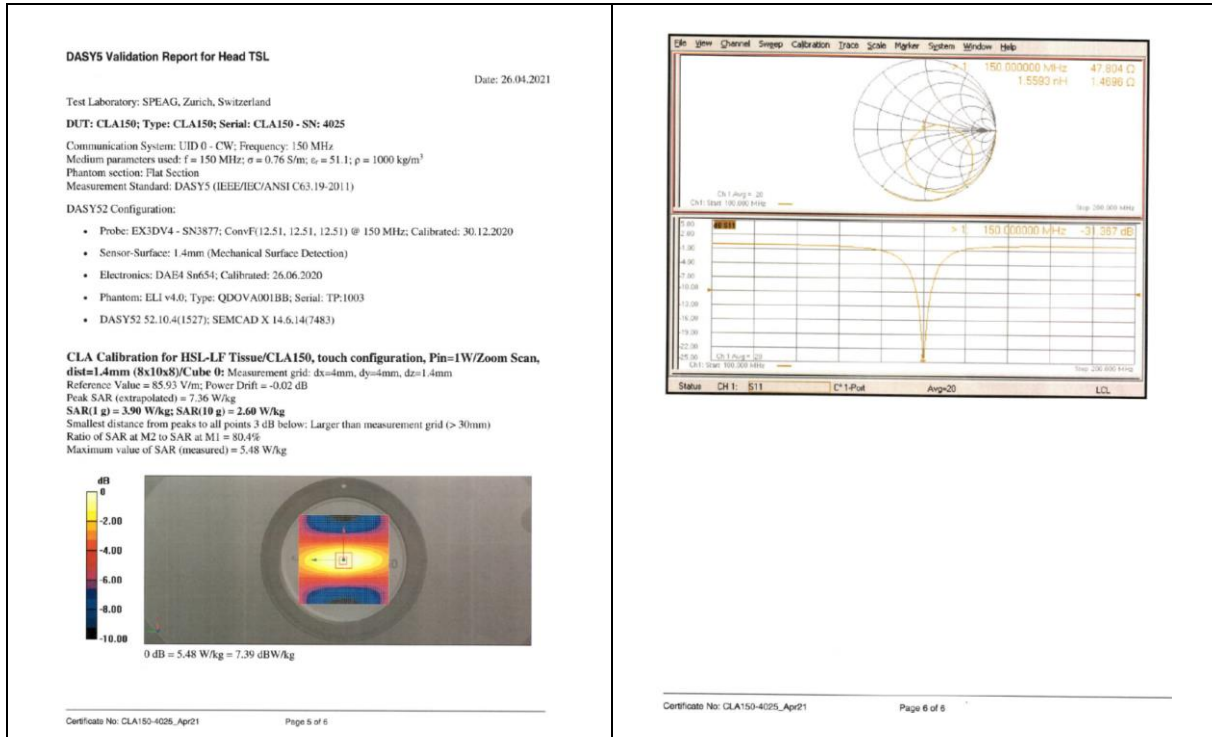
Certificate No: CLA150-4025_Apr21	
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1.2 D450V3 - SN 1103

Calibration Laboratory of Schmid & Partner Engineering AG
Zweigschulstrasse 43, 8604 Zurich, Switzerland

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Client: **SGS-CN (Aude)** Certificate No: **D450V3-1103_Apr21**

CALIBRATION CERTIFICATE

Object: **D450V3 - SN: 1103**

Calibration procedure(s): **QA CAL-15-v9**
Calibration Procedure for SAR Validation Sources below 700 MHz

Calibration date: **April 21, 2021**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (20 ± 2) °C and humidity < 70%.

Calibration Equipment used (MPE: critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03021/03020)	Apr-22
Power sensor MHP-291	SN: 102344	09-Apr-21 (No. 217-03021)	Apr-22
Power sensor MHP-291	SN: 102345	09-Apr-21 (No. 217-03020)	Apr-22
Reference 20 dB Attenuator	SN: CC2852 (200)	09-Apr-21 (No. 217-03345)	Apr-22
Type-N mismatch combination	SN: 310827 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe E30309	SN: 3877	30-Dec-20 (No. E30-3877_Dec20)	Dec-21
DAEA	SN: 654	26-Jun-20 (No. D454-654_Jun20)	Jun-21

Secondary Standards

ID #	Check Date (in house)	Scheduled Check
Power meter E44198	09-Apr-21 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	09-Apr-21 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	09-Apr-21 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8548C	09-Apr-21 (in house check Jun-20)	In house check: Jun-22
Network Analyzer Agilent E8358A	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by: **Christoph Leuber** Function: **Laboratory Technician**

Approved by: **Kelly Polovic** Technical Manager

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Accreditation No: **SCS 0106**

Glossary:

TSL: Issue simulating liquid sensitivity in TSL / NORM x,y,z

ConvF: not applicable or not measured

N/A: not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC 61010-1:2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

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Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V62.10.4
Extrapolation	Advanced Extrapolation	
Phantom	ELJ Flat Phantom	Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	43.5	0.57 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	43.1 ± 6 %	0.07 mho/m ± 8 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	4.55 W/kg ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.757 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	3.06 W/kg ± 17.6 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	57.1 Ω - j2.6 jΩ
Return Loss	-23.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.346 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Test Laboratory: SPEAG, Zurich, Switzerland

Date: 21.04.2021

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1103

Communication System: UTD 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450 \text{ MHz}$; $\alpha = 0.87 \text{ S/m}$; $\epsilon_r = 43.1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.64, 10.64, 10.64) @ 450 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 26.06.2020
- Phantom: ELJ v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.18 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 1.76 W/kg

SAR(1 g) = 1.14 W/kg; SAR(10 g) = 0.767 W/kg

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid

Ratio of SAR at M2 to SAR at M1 = 64.9%

Maximum value of SAR (measured) = 1.53 W/kg

0 dB = 1.53 W/kg = 1.85 dBW/kg

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1.3 D750V3 - SN 1188

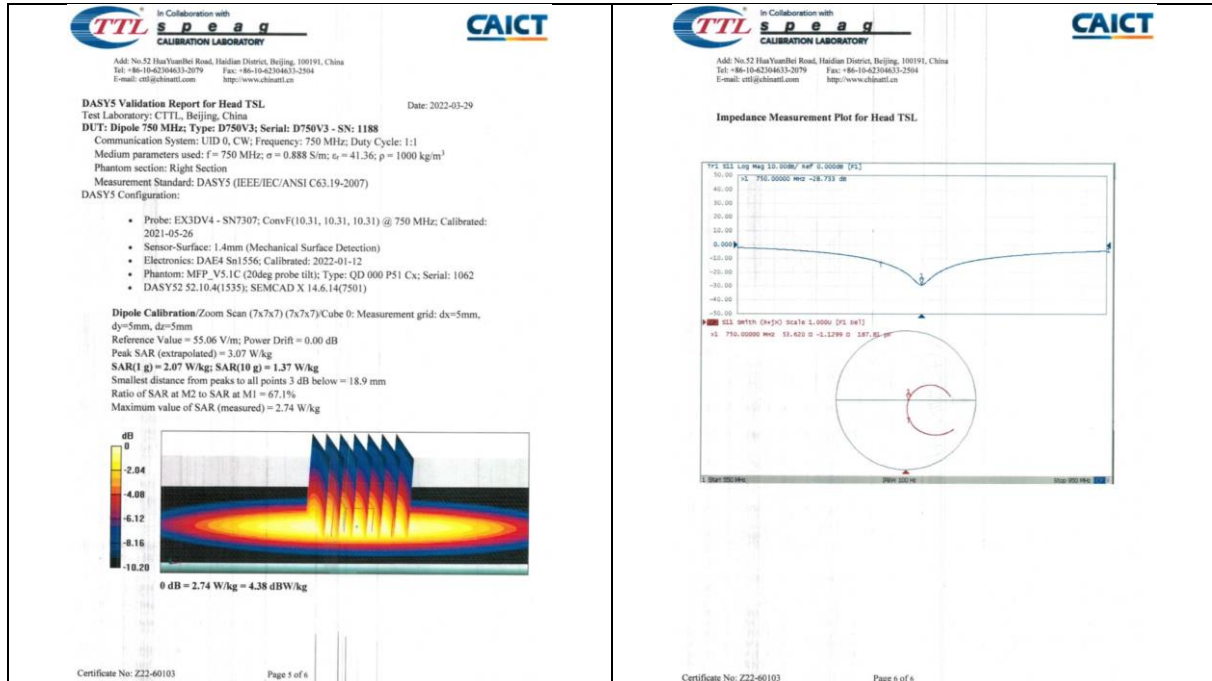
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Client: SGS-CN		Certificate No: Z22-60103																					
CALIBRATION CERTIFICATE																							
Object: D750V3 - SN: 1188																							
Calibration Procedure(s): FF-Z11-003-01 Calibration Procedures for dipole validation kits																							
Calibration date: March 28, 2022																							
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Network Analyzer E5071C	MY48110673	14-Jan-22 (CTTL No.J22X00409)	Jan-23																				
Calibrated by: Zhao Jing SAR Test Engineer																							
Reviewed by: Lin Hao SAR Test Engineer																							
Approved by: Qi Dianyan SAR Project Leader																							
Issued: April 3, 2022																							
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Measurement Conditions DASY system configuration, as far as not given on page 1:																					
<table border="1"><thead><tr><th>DASY Version</th><th>DASY52</th><th>V52.10.4</th></tr></thead><tbody><tr><td>Extrapolation</td><td>Advanced Extrapolation</td><td></td></tr><tr><td>Phantom</td><td>Triple Flat Phantom 5.1C</td><td></td></tr><tr><td>Distance Dipole Center - TSL</td><td>15 mm</td><td>with Spacer</td></tr><tr><td>Zoom Scan Resolution</td><td>dx, dy, dz = 5 mm</td><td></td></tr><tr><td>Frequency</td><td>750 MHz ± 1 MHz</td><td></td></tr></tbody></table>				DASY Version	DASY52	V52.10.4	Extrapolation	Advanced Extrapolation		Phantom	Triple Flat Phantom 5.1C		Distance Dipole Center - TSL	15 mm	with Spacer	Zoom Scan Resolution	dx, dy, dz = 5 mm		Frequency	750 MHz ± 1 MHz	
DASY Version	DASY52	V52.10.4																			
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<table border="1"><thead><tr><th></th><th>Temperature</th><th>Permittivity</th><th>Conductivity</th></tr></thead><tbody><tr><td>Nominal Head TSL parameters</td><td>22.0 °C</td><td>42.0</td><td>0.90 mho/m</td></tr><tr><td>Measured Head TSL parameters</td><td>(22.0 ± 0.2) °C</td><td>41.4 ± 6 %</td><td>0.89 mho/m ± 6 %</td></tr><tr><td>Head TSL temperature change during test</td><td><1.0 °C</td><td>---</td><td>---</td></tr></tbody></table>					Temperature	Permittivity	Conductivity	Nominal Head TSL parameters	22.0 °C	42.0	0.90 mho/m	Measured Head TSL parameters	(22.0 ± 0.2) °C	41.4 ± 6 %	0.89 mho/m ± 6 %	Head TSL temperature change during test	<1.0 °C	---	---		
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Glossary:			
TSL	tissue simulating liquid		
ConVF	sensitivity in TSL / NORMx.y.z		
N/A	not applicable or not measured		
Calibration is Performed According to the Following Standards:			
a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020			
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"			
Additional Documentation:			
c) DASY4/5 System Handbook			
Methods Applied and Interpretation of Parameters:			
• Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.			
• Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.			
• Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.			
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The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.			
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Appendix (Additional assessments outside the scope of CNAS L0570)							
Antenna Parameters with Head TSL							
<table border="1"><thead><tr><th>Impedance, transformed to feed point</th><th>53.60- 1.13jΩ</th></tr><tr><th>Return Loss</th><th>-28.7dB</th></tr></thead></table>				Impedance, transformed to feed point	53.60- 1.13jΩ	Return Loss	-28.7dB
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<table border="1"><thead><tr><th>Electrical Delay (one direction)</th><th>0.947 ns</th></tr></thead></table>				Electrical Delay (one direction)	0.947 ns		
Electrical Delay (one direction)	0.947 ns						
After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point can be measured.							
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.							
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be damaged.							
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<table border="1"><thead><tr><th>Manufactured by</th><th>SPEAG</th></tr></thead></table>				Manufactured by	SPEAG		
Manufactured by	SPEAG						
Certificate No: Z22-60103		Page 4 of 6					





1.4 D835V2 - SN 4d114

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Client: **SGS-CN** Certificate No: **Z22-60104**

CALIBRATION CERTIFICATE

Object: **D835V2 - SN: 4d114**

Calibration Procedure(s): **FF-Z11-003-01**
Calibration Procedures for dipole validation kits

Calibration date: **March 31, 2022**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22±3)°C and humidity <70%.

Calibration Equipment used (M&E critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Power sensor NRPBS	104261	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Reference Probe EX3DV4	SN 7307	26-May-21 (SPEAG No.EX3-7307_May21)	May-22
DAE4	SN 1556	12-Jan-22 (CTTL-SPEAG No.Z22-60007)	Jan-23

Secondary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL No.J22X00409)	Jan-23
Network Analyzer E5071C	MY46110673	14-Jan-22 (CTTL No.J22X00409)	Jan-23

Calibrated by: **Zhao Jing** SAR Test Engineer

Reviewed by: **Lin Hao** SAR Test Engineer

Approved by: **Qi Diqian** SAR Project Leader

Issued: April 6, 2022

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Glossary:

TSL: tissue simulating liquid
ConvF: sensitivity in TSL / NORMx.y.z
N/A: not applicable or not measured

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a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
b) KDB 865864, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

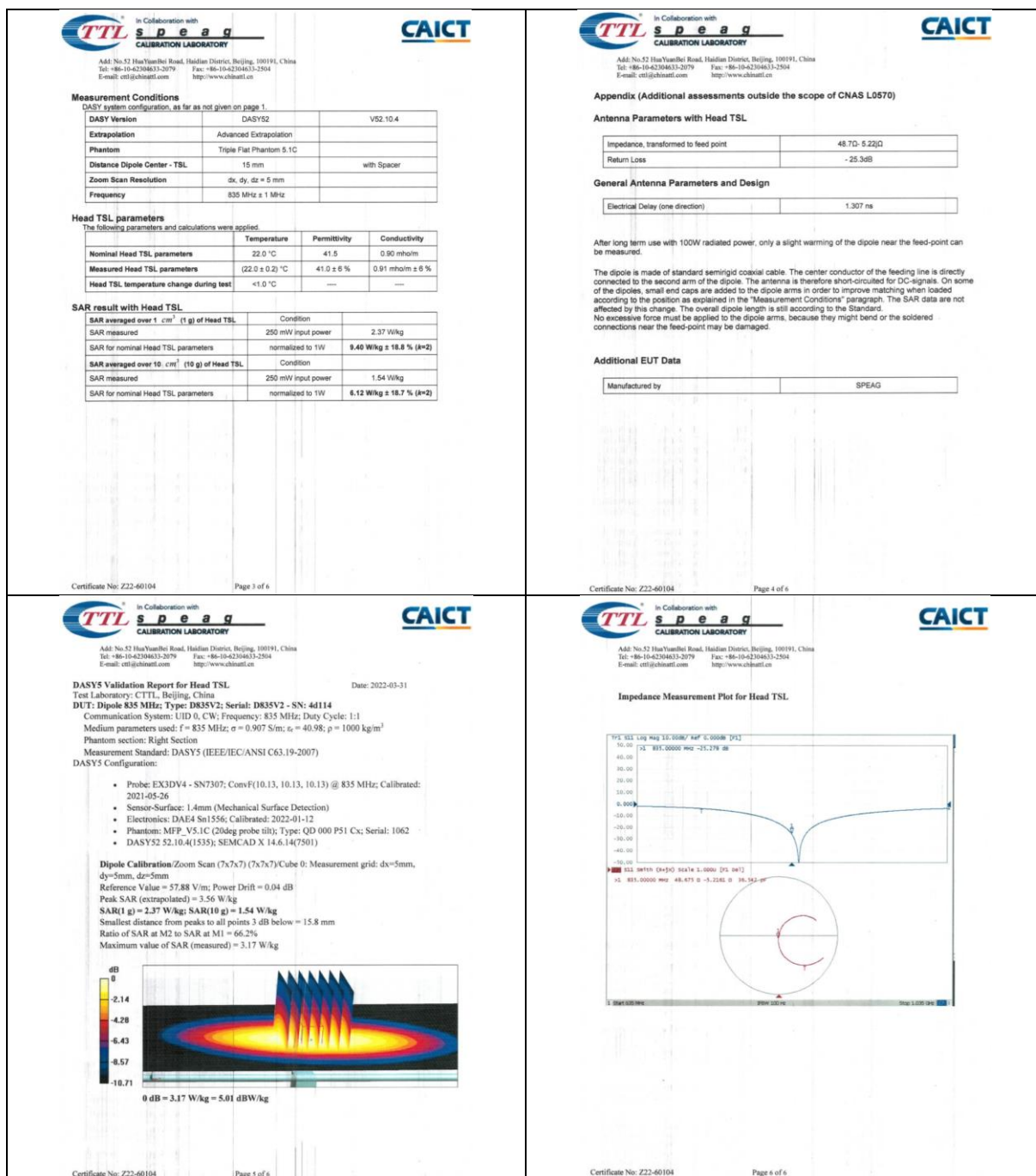
c) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
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- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

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1.5 D900V2 - SN 1d079

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Client: SGS-CN		Certificate No: Z22-60184																					
CALIBRATION CERTIFICATE																							
Object: D900V2 - SN: 1d079																							
Calibration Procedure(s): FF-Z11-003-01 Calibration Procedures for dipole validation kits																							
Calibration date: June 7, 2022																							
This Calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.																							
All calibrations have been conducted in the closed laboratory facility: environment temperature (23±1)°C and humidity <70%.																							
Calibration Equipment used (MATE critical for calibration)																							
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Approved by: Qi Dianyan SAR Project Leader Signature																							
Issued: June 13, 2022																							
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Certificate No: Z22-60184		Page 3 of 6																			

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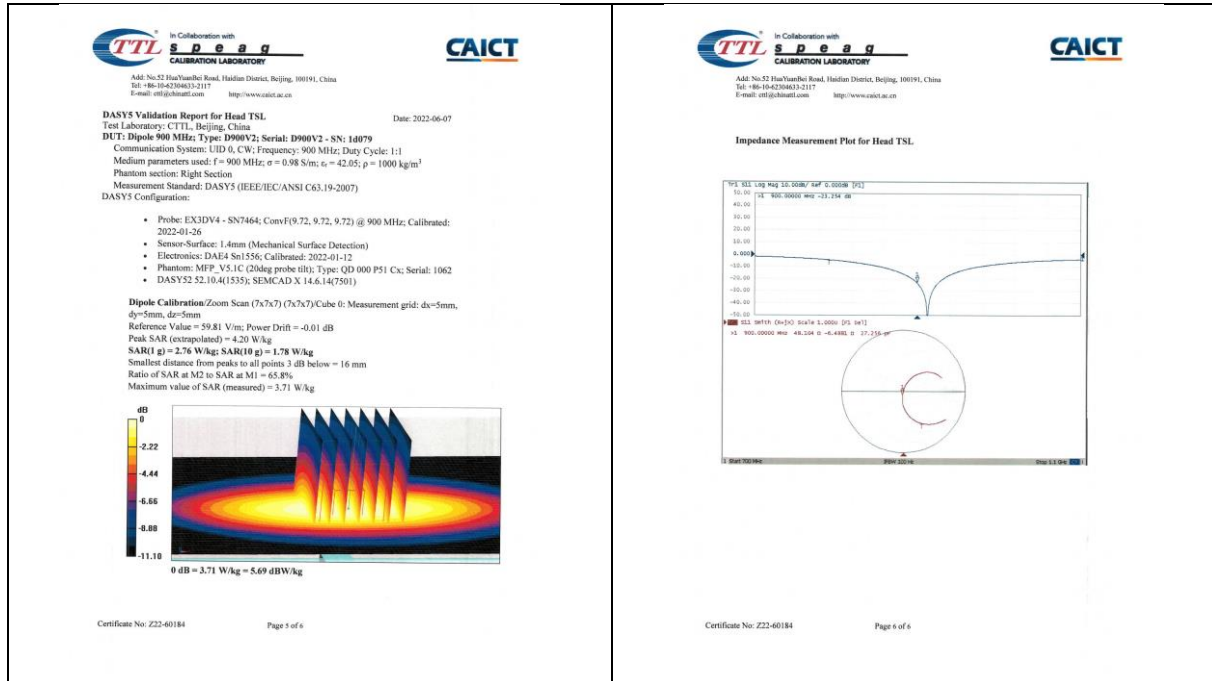
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1.6 D1800V2 - SN 2d170

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E-mail: cti@china.ttl.com http://www.china.ttl.com

Client: **SGS-CN** Certificate No: **Z22-60105**

CALIBRATION CERTIFICATE

Object: **D1800V2 - SN: 2d170**

Calibration Procedure(s): **FF-Z11-003-01**
Calibration Procedures for dipole validation kits

Calibration date: **March 31, 2022**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility, environment temperature (22±3)°C and humidity <70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Power sensor NRP8S	104291	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Reference Probe EX3DV4	SN 7307	26-May-21 (SPEAG No.EX3-7307_May21)	May-22
DAE4	SN 1556	12-Jan-22 (CTTL-SPEAG No.Z22-60007)	Jan-23

Secondary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL No.J22X00409)	Jan-23
Network Analyzer E5071C	MY46110573	14-Jan-22 (CTTL No.J22X00409)	Jan-23

Calibrated by: **Zhao Jing** SAR Test Engineer
Reviewed by: **Lin Hao** SAR Test Engineer
Approved by: **Qi Diqian** SAR Project Leader

Issued April 6, 2022

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Glossary:
TSL: tissue simulating liquid
ConvF: sensitivity in TSL / NORMx,y,z
N/A: not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:
c) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

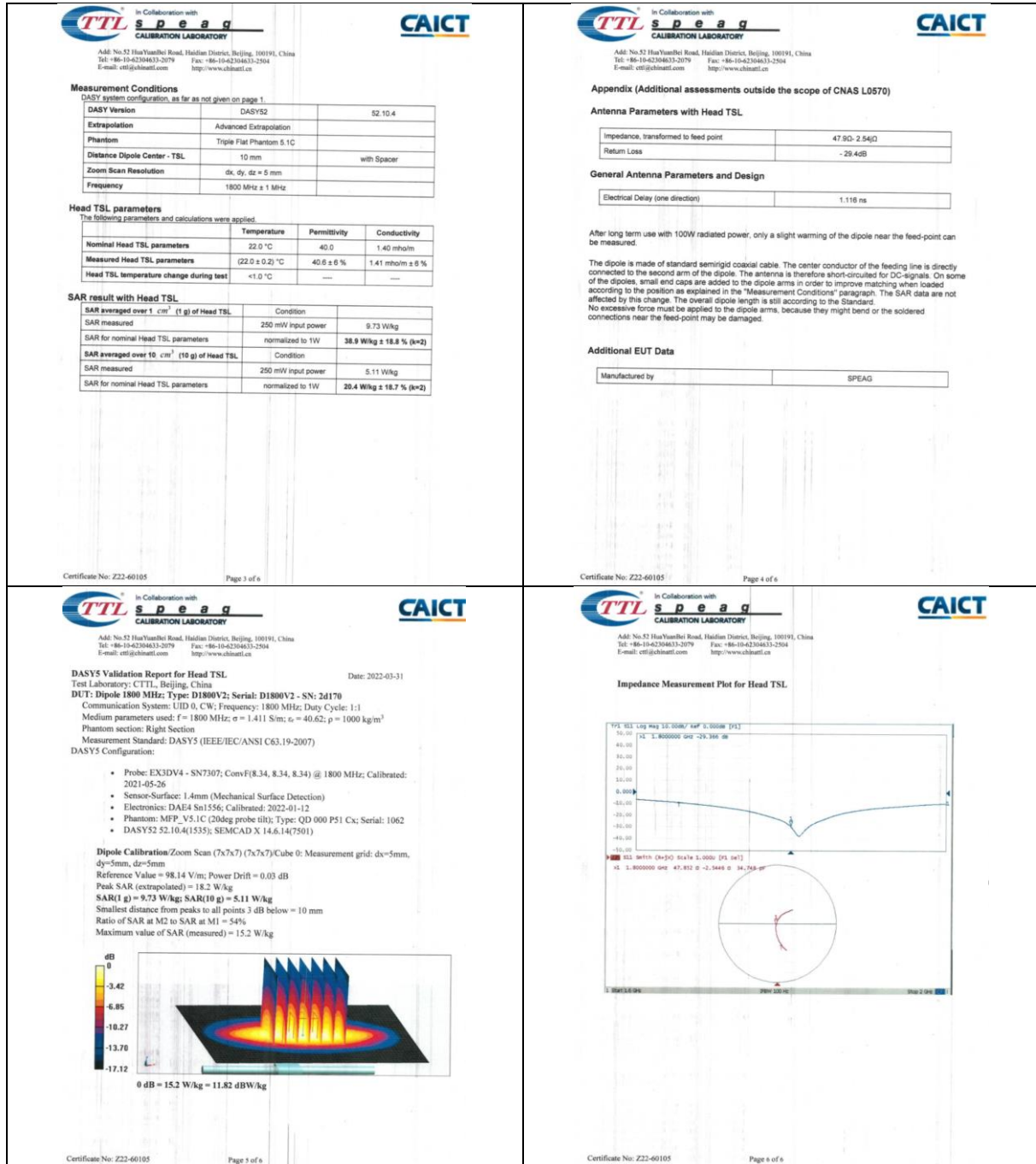
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1.7 D1900V2 - SN 5d136

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Client: SGS-CN		Certificate No: Z22-60185	
CALIBRATION CERTIFICATE			
Object	D1900V2 - SN: 5d136		
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits		
Calibration date:	June 7, 2022		
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature (23±1)°C and humidity<70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Calibrated by: Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Power sensor NRP6S	104291	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Reference Probe EXSDV4	SN 7464	28-Jan-22 (SPEAG No EX3-7464_Jan22)	Jan-23
DAE4	SN 1656	12-Jan-22 (CTTL-SPEAG No Z22-60007)	Jan-23
Secondary Standards	ID #	Cal Date (Calibrated by: Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY48071430	13-Jan-22 (CTTL No.J22X00409)	Jan-23
Network Analyser E5071C	MY48110073	14-Jan-22 (CTTL No.J22X00409)	Jan-23
Calibrated by:	Name	Function	Signature
	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Diqian	SAR Project Leader	
Issued: June 13, 2022			
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Certificate No: Z22-60185		Page 1 of 6	

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Measurement Conditions		Appendix (Additional assessments outside the scope of CNAS L0570)	
DASY system configuration, as far as not given on page 1:		Antenna Parameters with Head TSL	
DASY Version	DAEY52	Impedance, transformed to feed point	
Extrapolation	Advanced Extrapolation	51.02 ± 7.58Ω	
Phantom	Triple Flat Phantom 5.1C	Return Loss	
Distance Dipole Center - TSL	10 mm	-22.4dB	
Zoom Scan Resolution	dx, dy, dz = 5 mm	General Antenna Parameters and Design	
Frequency	1900 MHz ± 1 MHz	Electrical Delay (one direction)	
		1.109 ns	
Head TSL parameters		After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point can be measured.	
The following parameters and calculations were applied:		The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC signals. On some of the dipoles, small and caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be damaged.	
Nominal Head TSL parameters	Temperature	Permittivity	
Measured Head TSL parameters	22.0 ± 0.2 °C	40.0	
Head TSL temperature change during test	<1.0 °C	1.40 return	
SAR result with Head TSL		Additional EUT Data	
SAR averaged over 1 cm² (1 g) of Head TSL	Condition	Manufactured by	
SAR measured	250 mW input power	SPEAG	
SAR for nominal Head TSL parameters	normalized to 1W		
SAR averaged over 10 cm² (10 g) of Head TSL	Condition		
SAR measured	250 mW input power		
SAR for nominal Head TSL parameters	normalized to 1W		
	20.8 W/kg ± 18.7 % (k=2)		
Certificate No: Z22-60185		Page 3 of 6	

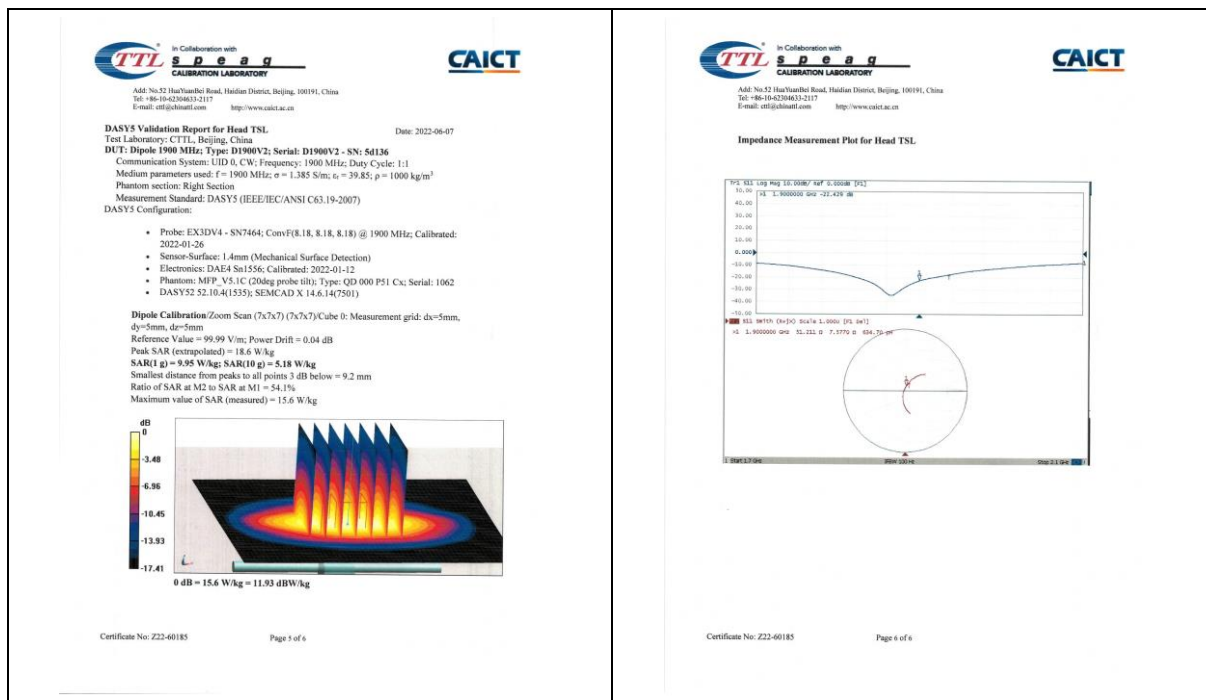
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Glossary:		TSL	
ConF		tissue simulating liquid	
NA		sensitivity in TSL / NORMx.y.z	
		not applicable or not measured	
Calibration is Performed According to the Following Standards:			
a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020			
b) KDB 865984, "SAR Measurement Requirements for 100 MHz to 6 GHz"			
Additional Documentation:			
c) DASY4/5 System Handbook			
Methods Applied and Interpretation of Parameters:			
• Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.			
• Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.			
• Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.			
• Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.			
• SAR measured: SAR measured at the stated antenna input power.			
• SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.			
• SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.			
The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.			
Certificate No: Z22-60185		Page 2 of 6	



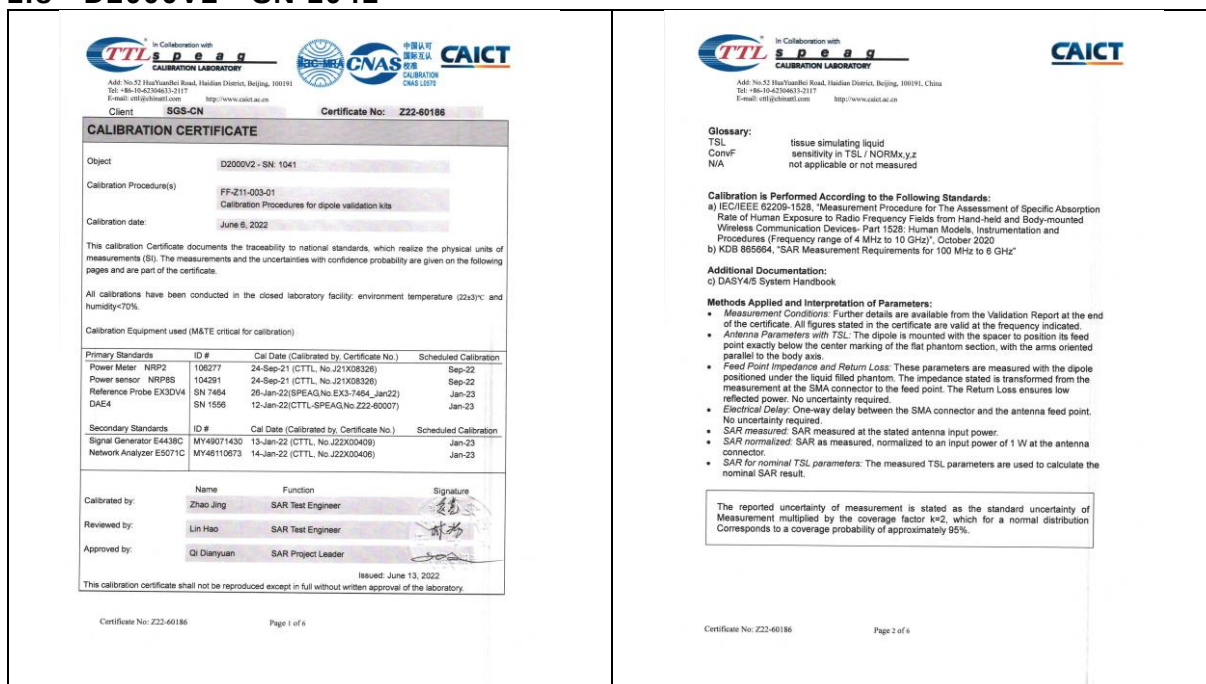
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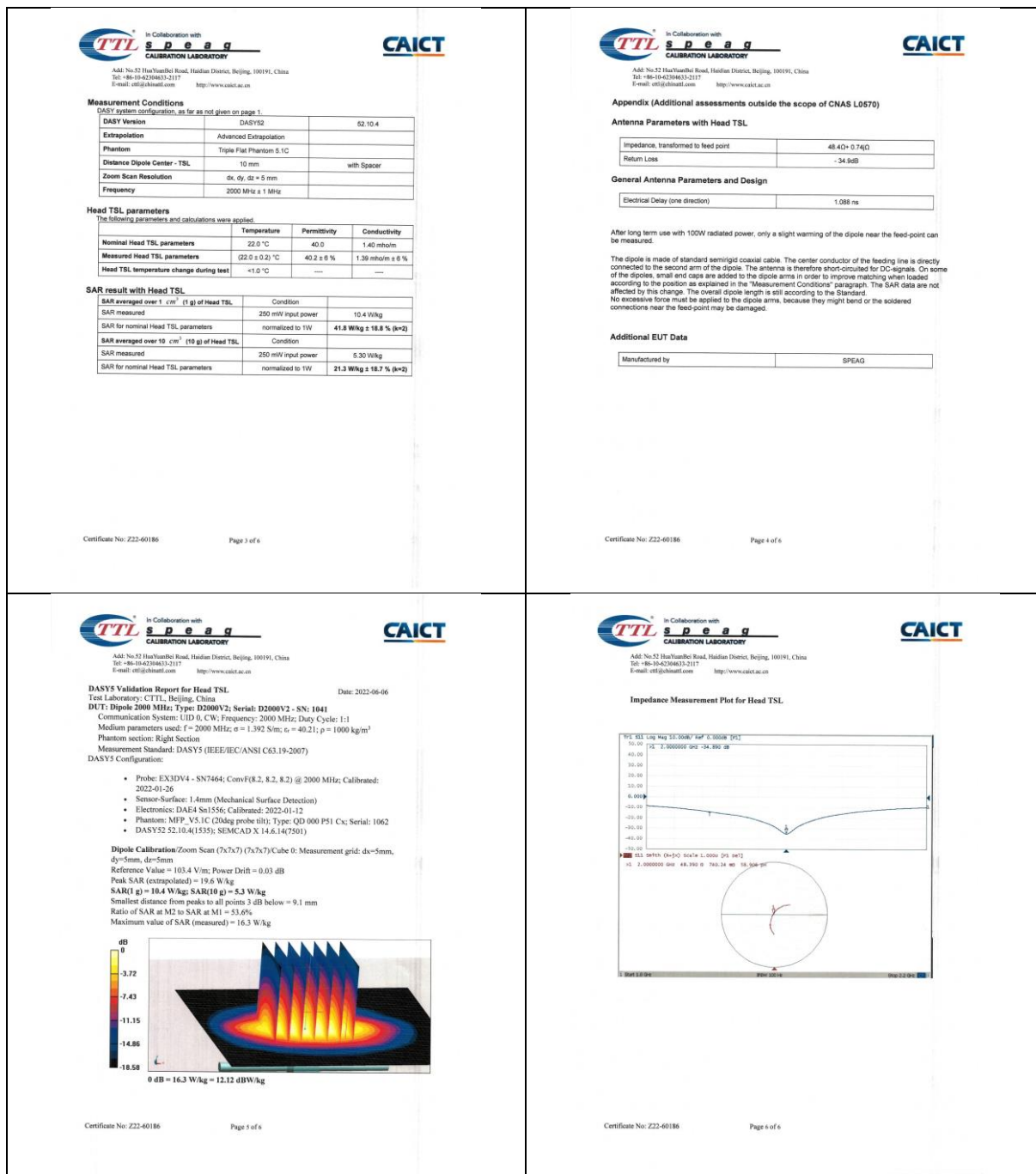
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1.8 D2000V2 - SN 1041





1.9 D2300V2 - SN 1096

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Client: SGS-CN		Certificate No: Z22-60106	
CALIBRATION CERTIFICATE			
Object	D2300V2 - SN: 1096		
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits		
Calibration date:	March 31, 2022		
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature (22±3)°C and humidity <70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Power Meter NRP2	108277	24-Sep-21 (CTTL No.J21X08328)	Sep-22
Power sensor NRP8S	104291	24-Sep-21 (CTTL No.J21X08328)	Sep-22
Reference Probe EX30V4	SN 7307	26-May-21 (SPEAG No.EK3-7307_May21)	May-22
DAE4	SN 1556	12-Jan-22 (CTTL-SPEAG No.Z22-60007)	Jan-23
Secondary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL No.J22X00406)	Jan-23
Network Analyzer E5071C	MY48110673	14-Jan-22 (CTTL No.J22X00406)	Jan-23
Calibrated by:	Name	Function	Signature
	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Diqian	SAR Project Leader	
Issued: April 6, 2022			
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Measurement Conditions DASY system configuration, as far as not given on page 1:			
DASY Version	DASY2	52.10.4	
Extrapolation	Advanced Extrapolation		
Phantom	Triple Flat Phantom 5.1C		
Distance Dipole Center - TSL	10 mm	with Spacer	
Zoom Scan Resolution	dx, dy, dz = 5 mm		
Frequency	2300 MHz ± 1 MHz		
Head TSL parameters The following parameters and calculations were applied:			
	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.8 ± 6 %	1.70 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	—	—
SAR result with Head TSL			
SAR averaged over 1 cm ² (1 g) of Head TSL	Condition		
SAR measured	250 mW input power	12.4 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	49.2 W/kg ± 18.8 % (k=2)	
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition		
SAR measured	250 mW input power	5.88 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	23.4 W/kg ± 18.7 % (k=2)	
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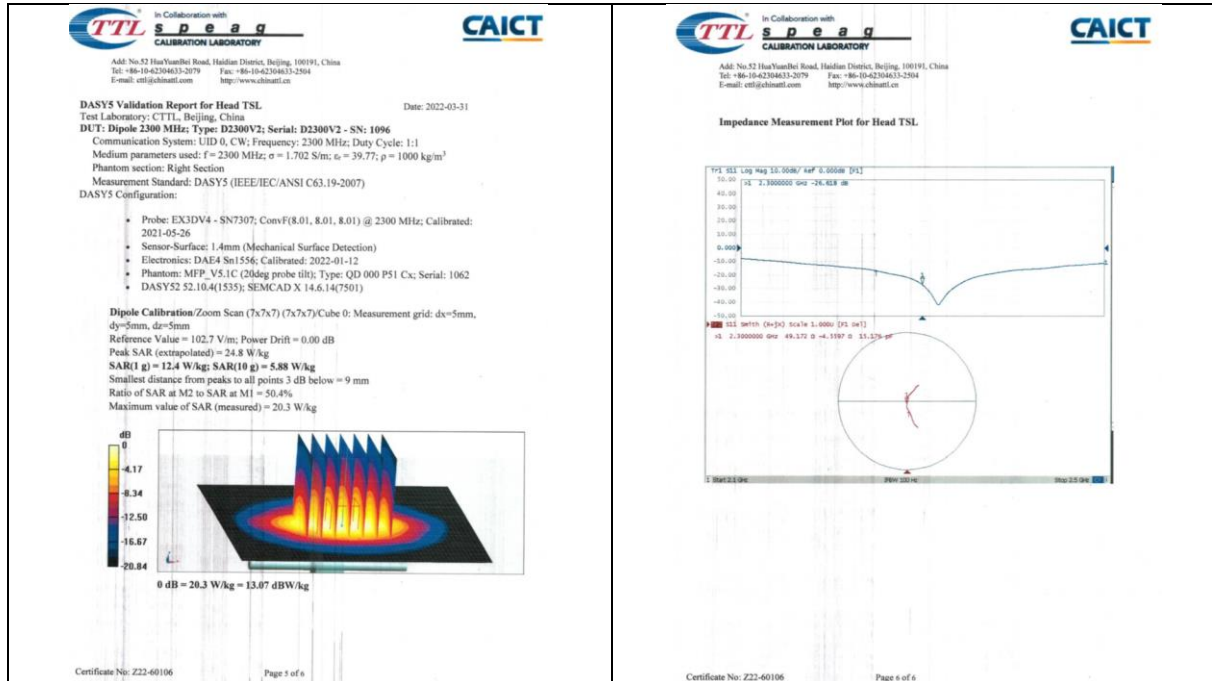
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Appendix (Additional assessments outside the scope of CNAS L0570)			
Antenna Parameters with Head TSL			
Impedance, transformed to feed point	49.20 - 4.56jΩ		
Return Loss	-26.6dB		
General Antenna Parameters and Design			
Electrical Delay (one direction)	1.083 ns		
After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point can be measured.			
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be damaged.			
Additional EUT Data			
Manufactured by	SPEAG		
Certificate No: Z22-60106		Page 4 of 6	



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1.10 D2450V2 - SN 817

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Client: **SGS-CN** Certificate No: **Z22-60107**

CALIBRATION CERTIFICATE

Object: **D2450V2 - SN: 817**

Calibration Procedure(s): **FF-Z11-003-01**
Calibration Procedures for dipole validation kits

Calibration date: **April 1, 2022**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22±3)°C and humidity <70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Power Meter: NRP2	106277	24-Sep-21 (CTTL No.J21X08320)	Sep-22
Power sensor: NRP8S	104291	24-Sep-21 (CTTL No.J21X08320)	Sep-22
Reference Probe EX3DV4	SN 7307	25-May-21 (SPEAG No EX3-7307_May21)	May-22
DAE4	SN 1556	12-Jan-22 (CTTL-SPEAG No Z22-60007)	Jan-23

Secondary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL No.J22X00406)	Jan-23
Network Analyzer E5071C	MY46110673	14-Jan-22 (CTTL No.J22X00406)	Jan-23

Calibrated by: **Zhao Jing** SAR Test Engineer
Reviewed by: **Lin Hao** SAR Test Engineer
Approved by: **Qi Dianyan** SAR Project Leader

Issued: April 6, 2022

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Glossary:

TSL: tissue simulating liquid
ConvF: sensitivity in TSL / NORMx.y.z
N/A: not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
b) KDB 855664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

c) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor $k=2$, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

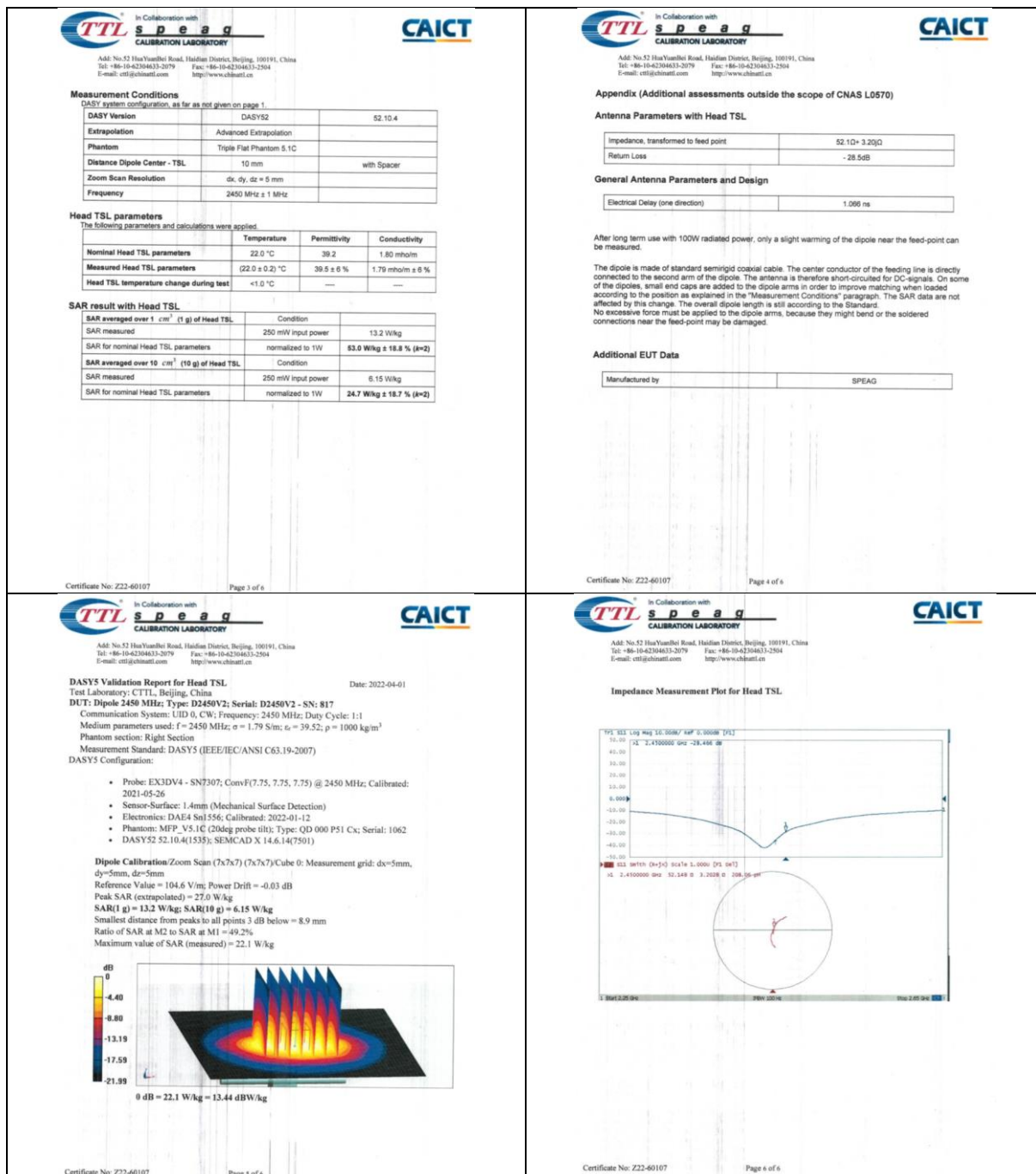
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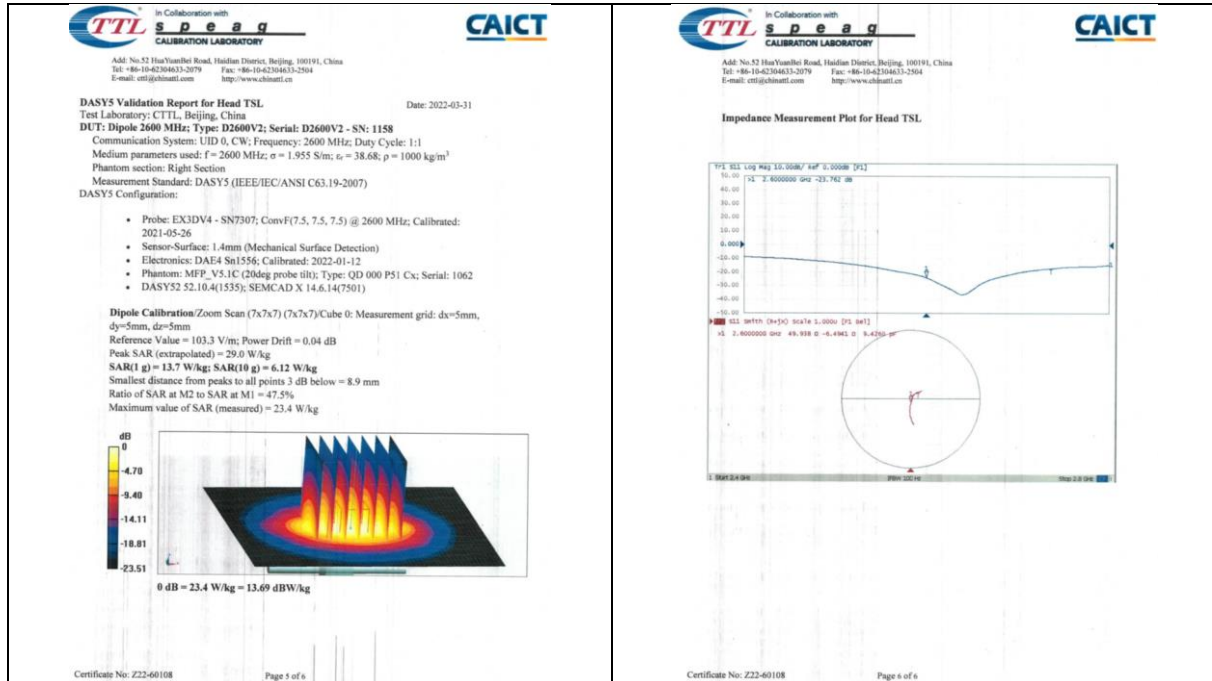
1.11 D2600V2 - SN 1158

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Client: SGS-CN		Certificate No: Z22-40108	
CALIBRATION CERTIFICATE			
Object	D2600V2 - SN: 1158		
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits		
Calibration date:	March 31, 2022		
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature (23±3)°C and humidity<70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Power Meter: NRP2	106277	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Power sensor: NRPBS	104291	24-Sep-21 (CTTL No.J21X08326)	Sep-22
Reference Probe EX3DVA	SN 7307	26-May-21 (SPEAG No EX3-7307_May21)	May-22
DAE4	SN 1556	12-Jan-22 (CTTL-SPEAG No Z22-60007)	Jan-23
Secondary Standards	ID #	Cal Date (Calibrated by Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL No.Z22X00406)	Jan-23
Network Analyzer E5071C	MY48110673	14-Jan-22 (CTTL No.Z22X00406)	Jan-23
Calibrated by:	Name: Zhao Jing	Function: SAR Test Engineer	Signature: [Signature]
Reviewed by:	Name: Lin Hao	Function: SAR Test Engineer	Signature: [Signature]
Approved by:	Name: Qi Diaryuan	Function: SAR Project Leader	Signature: [Signature]
Issued: April 6, 2022			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
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Measurement Conditions DASY system configuration, as far as not given on page 1:			
DASY Version	DASY2	52.10.4	
Extrapolation	Advanced Extrapolation		
Phantom	Triple Flat Phantom 5.1C		
Distance Dipole Center - TSL	10 mm	with Spacer	
Zoom Scan Resolution	dx, dy, dz = 5 mm		
Frequency	2600 MHz ± 1 MHz		
Head TSL parameters The following parameters and calculations were applied:			
	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.7 ± 6 %	1.96 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---
SAR result with Head TSL			
SAR averaged over 1 cm ² (1 g) of Head TSL	Condition		
SAR measured	250 mW input power	13.7 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	54.8 W/kg ± 18.8 % (k=2)	
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition		
SAR measured	250 mW input power	6.12 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	24.6 W/kg ± 18.7 % (k=2)	
Certificate No: Z22-40108		Page 3 of 6	

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Glossary:			
TSL	tissue simulating liquid		
ConvF	sensitivity in TSL / NORMx.y.z		
N/A	not applicable or not measured		
Calibration is Performed According to the Following Standards:			
a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices - Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020			
b) KDB 865864, "SAR Measurement Requirements for 100 MHz to 6 GHz"			
Additional Documentation:			
c) DASY4/S System Handbook			
Methods Applied and Interpretation of Parameters:			
• Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.			
• Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.			
• Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.			
• Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.			
• SAR measured: SAR measured at the stated antenna input power.			
• SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.			
• SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.			
The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.			
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Appendix (Additional assessments outside the scope of CNAS L0570)			
Antenna Parameters with Head TSL			
Impedance, transformed to feed point	49.90- 6.49jΩ		
Return Loss	- 23.8dB		
General Antenna Parameters and Design			
Electrical Delay (one direction)	1.053 ns		
After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point can be measured.			
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.			
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be damaged.			
Additional EUT Data			
Manufactured by	SPEAG		
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1.12 D5GHZV2 - SN 1095

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Client: SGS-CN		Certificate No: Z22-60187																					
CALIBRATION CERTIFICATE																							
Object: D5GHZV2 - SN: 1095																							
Calibration Procedure(s): FF-Z11-003-01 Calibration Procedures for dipole validation kits																							
Calibration date: June 1, 2022																							
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.																							
All calibrations have been conducted in the closed laboratory facility: environment temperature (23±3)°C and humidity <70%.																							
Calibration Equipment used (M&TE critical for calibration)																							
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<table border="1"><thead><tr><th>Name</th><th>Function</th><th>Signature</th></tr></thead><tbody><tr><td>Calibrated by: Zhao Jing</td><td>SAR Test Engineer</td><td></td></tr><tr><td>Reviewed by: Lin Hao</td><td>SAR Test Engineer</td><td></td></tr><tr><td>Approved by: Qi Dianyan</td><td>SAR Project Leader</td><td></td></tr></tbody></table>				Name	Function	Signature	Calibrated by: Zhao Jing	SAR Test Engineer		Reviewed by: Lin Hao	SAR Test Engineer		Approved by: Qi Dianyan	SAR Project Leader									
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Calibrated by: Zhao Jing	SAR Test Engineer																						
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Glossary: TSL: Issue simulating liquid sensitivity in TSL: NORMx,y,z N/A: not applicable or not measured			
Calibration is Performed According to the Following Standards: a) IEC/IEEE 62209-1528, 'Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices-Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)', October 2020 b) KDB 665664, "SAR Measurement Requirements for 100 MHz to 6 GHz"			
Additional Documentation: c) DASY4/5 System Handbook			
Methods Applied and Interpretation of Parameters: • Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. • Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis. • Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required. • Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required. • SAR measured: SAR measured at the stated antenna input power. • SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector. • SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.			
The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.			

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Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY2	52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	4.62 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5200MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	7.79 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.6 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.1 W/kg ± 24.2 % (k=2)

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Head TSL parameters at 5300MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	4.73 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5300MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.1 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 W/kg ± 24.2 % (k=2)

Head TSL parameters at 5500MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.8	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.8 ± 6 %	4.94 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5500MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	62.6 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 24.2 % (k=2)

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Head TSL parameters at 5600MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	5.05 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5600MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.8 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.9 W/kg ± 24.2 % (k=2)

Head TSL parameters at 5800MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	5.25 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5800MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.7 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.8 W/kg ± 24.2 % (k=2)

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5200MHz

Impedance, transformed to feed point	48.1D-5.03jΩ
Return Loss	-23.6dB

Antenna Parameters with Head TSL at 5300MHz

Impedance, transformed to feed point	47.8D-2.42jΩ
Return Loss	-28.5dB

Antenna Parameters with Head TSL at 5500MHz

Impedance, transformed to feed point	50.3D-4.26jΩ
Return Loss	-27.4dB

Antenna Parameters with Head TSL at 5600MHz

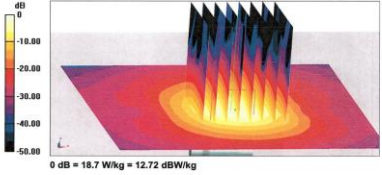
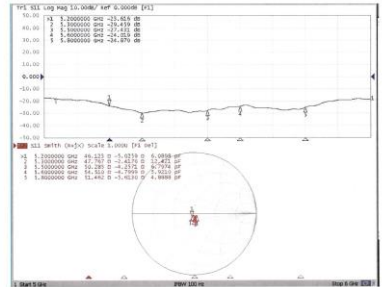
Impedance, transformed to feed point	54.5D-4.80jΩ
Return Loss	-24.0dB

Antenna Parameters with Head TSL at 5800MHz

Impedance, transformed to feed point	51.5D-5.61jΩ
Return Loss	-24.9dB

Certificate No: Z22-60187

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In Collaboration with TTL speaq CALIBRATION LABORATORY CAICT Address: No.52 Huayuan Road, Haidian District, Beijing, 100191, China Tel: +86-10-62302117 E-mail: cn@sgs.com http://www.caict.ac.cn General Antenna Parameters and Design <table border="1"><tr><td>Electrical Delay (one direction)</td><td>1.101 ns</td></tr></table> After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point can be measured. The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be damaged. Additional EUT Data <table border="1"><tr><td>Manufactured by</td><td>SPEAG</td></tr></table> Certificate No: Z22-60187 Page 7 of 10	Electrical Delay (one direction)	1.101 ns	Manufactured by	SPEAG	In Collaboration with TTL speaq CALIBRATION LABORATORY CAICT Address: No.52 Huayuan Road, Haidian District, Beijing, 100191, China Tel: +86-10-62302117 E-mail: cn@sgs.com http://www.caict.ac.cn DASY5 Validation Report for Head TSL Test Laboratory: CTTL, Beijing, China Date: 2022-06-01 DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1095 Communication System: CW; Frequency: 5200 MHz; Frequency: 5300 MHz; Frequency: 5500 MHz; Frequency: 5600 MHz; Frequency: 5800 MHz; Duty Cycle: 1:1 Medium parameters used: $f = 5200 \text{ MHz}$; $\sigma = 4.62 \text{ S/m}$; $\epsilon = 35.19$; $\rho = 1000 \text{ kg/m}^3$ Medium parameters used: $f = 5300 \text{ MHz}$; $\sigma = 4.73 \text{ S/m}$; $\epsilon = 35.19$; $\rho = 1000 \text{ kg/m}^3$ Medium parameters used: $f = 5500 \text{ MHz}$; $\sigma = 4.939 \text{ S/m}$; $\epsilon = 34.83$; $\rho = 1000 \text{ kg/m}^3$ Medium parameters used: $f = 5600 \text{ MHz}$; $\sigma = 5.051 \text{ S/m}$; $\epsilon = 34.89$; $\rho = 1000 \text{ kg/m}^3$ Medium parameters used: $f = 5800 \text{ MHz}$; $\sigma = 5.247 \text{ S/m}$; $\epsilon = 34.42$; $\rho = 1000 \text{ kg/m}^3$ Phantom section: Right Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) DASY5 Configuration: - Probe: EX3DV4 - SN7484; ConvF(5.6, 5.6, 5.6) @ 5200 MHz; ConvF(5.32, 5.32, 5.32) @ 5300 MHz; ConvF(5.11, 5.11, 5.11) @ 5500 MHz; ConvF(4.91, 4.91, 4.91) @ 5600 MHz; ConvF(5, 5, 5) @ 5800 MHz; Calibrated: 2022-01-26 - Sensor-Surface: 1.4mm (Mechanical Surface Detection) - Electronics: DA64 Sn1556; Calibrated: 2022-01-12 - Phantom: MPF_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062 - DASY52 52.10.4(1535); SEMCAD X 14.6.14(7601) Dipole Calibration /Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 60.80 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 29.8 W/kg SAR(1 g) = 7.79 W/kg; SAR(10 g) = 2.22 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 66.8% Maximum value of SAR (measured) = 18.3 W/kg Dipole Calibration /Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 61.08 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 31.5 W/kg SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 65.5% Maximum value of SAR (measured) = 19.0 W/kg Certificate No: Z22-60187 Page 8 of 10
Electrical Delay (one direction)	1.101 ns				
Manufactured by	SPEAG				
In Collaboration with TTL speaq CALIBRATION LABORATORY CAICT Address: No.52 Huayuan Road, Haidian District, Beijing, 100191, China Tel: +86-10-62302117 E-mail: cn@sgs.com http://www.caict.ac.cn Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 61.92 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 34.7 W/kg SAR(1 g) = 8.20 W/kg; SAR(10 g) = 2.34 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 63.9% Maximum value of SAR (measured) = 20.2 W/kg Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.08 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 35.2 W/kg SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.3 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 62.5% Maximum value of SAR (measured) = 19.1 W/kg Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.13 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 34.8 W/kg SAR(1 g) = 7.71 W/kg; SAR(10 g) = 2.16 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 61.6% Maximum value of SAR (measured) = 18.7 W/kg 0 dB = 16.7 W/kg = 12.72 dBW/kg  Certificate No: Z22-60187 Page 9 of 10	In Collaboration with TTL speaq CALIBRATION LABORATORY CAICT Address: No.52 Huayuan Road, Haidian District, Beijing, 100191, China Tel: +86-10-62302117 E-mail: cn@sgs.com http://www.caict.ac.cn Impedance Measurement Plot for Head TSL  Certificate No: Z22-60187 Page 10 of 10				

2 DAE4 - SN 1245

Schmid & Partner Engineering AG Zugstrasse 10, 8004 Zurich, Switzerland Phone +41 44 245 9700, Fax +41 44 245 9770 www.sgs.china, info@sgs.china s p e a g IMPORTANT NOTICE USAGE OF THE DAE4 The DAE4 unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE4. Special attention shall be given to the following points: Battery Exchange: The battery cover of the DAE4 unit is fixed using a screw, over tightening the screw may cause the threads inside the DAE4 to wear out. Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an anti-static bag. This anti-static bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside. E-stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE4 carefully and keep the DAE4 unit in a non-dusty environment if not used for measurements. Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect. DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE4 unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file. Important Note: Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer. Important Note: Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure. Important Note: To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE. TN_EH190306AE DAE4.docx 07.03.2019	Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 10, 8004 Zurich, Switzerland Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 0108 Client: SGS-CN (Auden) Certificate No.: DAE4-1245_May22 CALIBRATION CERTIFICATE Object: DAE4 - SD 000 D04 BM - SN: 1245 Calibration procedure(s): QA CAL-06 v30 Calibration procedure for the data acquisition electronics (DAE) Calibration date: May 30, 2022 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility; environment temperature (22 ± 3) °C and humidity < 70%. Calibration Equipment used (MATE critical for calibration) <table border="1"><thead><tr><th>Primary Standards</th><th>ID #</th><th>Cal Date (Certificate No.)</th><th>Scheduled Calibration</th></tr></thead><tbody><tr><td>Kettway Multimeter Type 2001</td><td>SN: 0810276</td><td>31-Aug-21 (No.31368)</td><td>Aug-22</td></tr></tbody></table> <table border="1"><thead><tr><th>Secondary Standards</th><th>ID #</th><th>Check Date (in house)</th><th>Scheduled Check</th></tr></thead><tbody><tr><td>Auto DAE Calibration Unit</td><td>SE LWS 003 AA 1001</td><td>24-Jan-22 (in house check)</td><td>In house check: Jan-23</td></tr><tr><td>Calibrator Box V2.1</td><td>SE LWS 006 AA 1002</td><td>24-Jan-22 (in house check)</td><td>In house check: Jan-23</td></tr></tbody></table> Calibrated by: Dominique Stettin Function: Laboratory Technician Signature: <i>[Signature]</i> Approved by: Ben Kohn Technical Manager Signature: <i>[Signature]</i> This calibration certificate shall not be reproduced except in full without written approval of the laboratory. Certificate No: DAE4-1245_May22 Page 1 of 5	Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Kettway Multimeter Type 2001	SN: 0810276	31-Aug-21 (No.31368)	Aug-22	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Auto DAE Calibration Unit	SE LWS 003 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23	Calibrator Box V2.1	SE LWS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23
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Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 10, 8004 Zurich, Switzerland Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 0108 Glossary DAE: data acquisition electronics Connector angle: information used in DASY system to align probe sensor X to the robot coordinate system. Methods Applied and Interpretation of Parameters • DC Voltage Measurement: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range. • Connector angle: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required. • The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty. • DC Voltage Measurement Linearity: Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement. • Common mode sensitivity: Influence of a positive or negative common mode voltage on the differential measurement. • Channel separation: Influence of a voltage on the neighbor channels not subject to an input voltage. • AD Converter Values with inputs shorted: Values on the internal AD converter corresponding to zero input voltage. • Input Offset Measurement: Output voltage and statistical results over a large number of zero voltage measurements. • Input Offset Current: Typical value for information; Maximum channel input offset current, not considering the input resistance. • Input resistance: Typical value for information; DAE input resistance at the connector, during internal auto-zeroing and during measurement. • Low Battery Alarm Voltage: Typical value for information. Below this voltage, a battery alarm signal is generated. • Power consumption: Typical value for information. Supply currents in various operating modes. Certificate No: DAE4-1245_May22 Page 2 of 5	DC Voltage Measurement AD - Converter Resolution nominal High Range: 1LSB = 6.1 μV, full range = -190...+920 mV Low Range: 1LSB = 61 μV, full range = -1...+3mV DASY measurement parameters: Auto Zero-Time: 3 sec; Measuring time: 3 sec <table border="1"><thead><tr><th>Calibration Factors</th><th>X</th><th>Y</th><th>Z</th></tr></thead><tbody><tr><td>High Range</td><td>405.265 ± 0.02% (k=2)</td><td>403.974 ± 0.02% (k=2)</td><td>406.092 ± 0.02% (k=2)</td></tr><tr><td>Low Range</td><td>3.99534 ± 1.50% (k=2)</td><td>3.99508 ± 1.50% (k=2)</td><td>4.01015 ± 1.50% (k=2)</td></tr></tbody></table> Connector Angle <table border="1"><thead><tr><th>Connector Angle to be used in DASY system</th><th>30.0° ± 1°</th></tr></thead></table> Certificate No: DAE4-1245_May22 Page 3 of 5	Calibration Factors	X	Y	Z	High Range	405.265 ± 0.02% (k=2)	403.974 ± 0.02% (k=2)	406.092 ± 0.02% (k=2)	Low Range	3.99534 ± 1.50% (k=2)	3.99508 ± 1.50% (k=2)	4.01015 ± 1.50% (k=2)	Connector Angle to be used in DASY system	30.0° ± 1°						
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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	19994.45	1.52	0.00
Channel X + Input	20004.58	2.22	0.01
Channel X - Input	-20001.14	1.12	-0.01
Channel Y + Input	19994.72	1.58	0.00
Channel Y + Input	20001.22	-1.00	-0.00
Channel Y - Input	-20003.05	-1.57	0.01
Channel Z + Input	19992.44	0.19	0.00
Channel Z + Input	20003.09	0.58	0.00
Channel Z - Input	-20001.73	-0.27	0.00

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2001.91	0.41	0.02
Channel X + Input	202.54	0.65	0.32
Channel X - Input	-197.86	0.07	-0.04
Channel Y + Input	2002.05	0.58	0.03
Channel Y + Input	201.27	-0.57	-0.28
Channel Y - Input	-196.23	-0.06	0.03
Channel Z + Input	2001.96	0.08	0.00
Channel Z + Input	200.09	-1.53	-0.76
Channel Z - Input	-199.85	-1.57	0.79

2. Common mode sensitivity

Channel	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	-200	-5.87	-7.69
Channel X	-200	9.12	7.79
Channel Y	-200	-8.68	-9.28
Channel Y	-200	8.52	6.36
Channel Z	-200	-5.36	-5.60
Channel Z	-200	3.58	3.06

3. Channel separation

Channel	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	4.07	-3.14
Channel Y	200	9.36	-	4.07
Channel Z	200	10.11	7.14	-

Certificate No: DAE4-1245_May22

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4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15984	17040
Channel Y	16062	16768
Channel Z	16035	15968

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	1.00	-0.15	1.93	0.45
Channel Y	-0.18	-1.28	0.94	0.45
Channel Z	-0.58	-2.81	0.58	0.60

6. Input Offset Current

Nominal input circuitry offset current on all channels: <25nA

7. Input Resistance (Typical values for information)

	Zeroing (ΩOff)	Measuring (MΩIn)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+8	+14
Supply (- Vcc)	-0.01	-8	-9

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3 EX3DV4 - SN 7767

Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 43, 8004 Zurich, Switzerland Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates	Schweizerischer Kalibrierdienst C Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service Accreditation No: SCS 0108																																										
Client: SGS-CN (Auden)	Certificate No: EX-7767_Oct22																																										
CALIBRATION CERTIFICATE																																											
Object: EX3DV4 - SN:7767																																											
Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes																																											
Calibration date: October 28, 2022																																											
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and humidity < 70%. Calibration Equipment used (DATE critical for calibration)																																											
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Calibrated by: Name: Adonis Georgiadou, Function: Laboratory Technician																																											
Approved by: Brian Kohn, Technical Manager																																											
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																																											
Certificate No: EX-7767_Oct22	Page 1 of 8																																										

Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 43, 8004 Zurich, Switzerland Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates	Schweizerischer Kalibrierdienst C Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service Accreditation No: SCS 0108
Glossary	
TSL	Issue simulating liquid
NORMA _{xyz}	sensitivity in free space
Conf ₁	sensitivity in TSL, NORMA _{xyz}
DCP	diode compression point
CP	crest factor (1/3 duty cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization θ	θ rotation around probe axis
Polarization φ	φ rotation around air axis that is in the plane normal to probe axis (at measurement center), i.e., φ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system
Calibration is Performed According to the Following Standards:	
a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.	
b) KDB 869864, "SAR Measurement Requirements for 100 MHz to 6 GHz"	
Methods Applied and Interpretation of Parameters:	
• NORMA _{xyz} : Assessed for E-field polarization θ = 0 (f < 800 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMA _{xyz} are only intermediate values, i.e., the uncertainties of NORMA _{xyz} does not affect the E-field uncertainty made TSL (see below Conf ₁).	
• NORMA _{xyz} + NORMA _{xyz} * frequency response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of Conf ₁ .	
• DCP _{xyz} : DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.	
• PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.	
• A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media, VR is the maximum calibration range expressed in RMS voltage across the diode.	
• Conf ₁ and Boundary Effect Parameters: Assessed in far phantom using E-field or Temperature Transfer Standard for f > 800 MHz and made waveguide using analytical field distribution based on power measurements for f < 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMA _{xyz} * Conf ₁ whereby the uncertainty corresponds to that given for Conf ₁ . A frequency dependent Conf ₁ is used in DASY version 4.4 and higher which allows extending the validity from < 80 MHz to > 100 MHz.	
• Spherical anisotropy (3D deviation from isotropy): In a field of low gradients realized using a flat phantom exposed by a patch antenna.	
• Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.	
• Connector Angle: The angle is assessed using the information gained by determining the NORMA (no uncertainty required).	
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Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm (μV/(mm ²)) ^A	0.87	0.89	0.56	±10.1%
DCP (mV) ^B	103.4	107.3	105.7	±4.7%

Calibration Results for Modulation Response

URS	Communication System Name	A	B	C	D	VR	Max	Max
		dB	dB/μV		dB	mV	dec.	Unc ^C
0	CW	X	0.00	0.00	1.00	0.00	184.7	±3.5%
		Y	0.00	0.00	1.00		186.7	±4.7%
		Z	0.00	0.00	1.00		179.3	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of Norm X,Y,Z do not affect the E₁-field uncertainty inside T85 (see Page 5).

^B Uncertainty parameter uncertainty for maximum specified field strength.

^C Uncertainty is determined using the min. deviation from three responses applying rectangular distribution and is expressed for the square of the field value.

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Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	144.8°
Mechanical Surface Detection Mode	angled
Optical Surface Detection Mode	displaced
Probe Overall Length	337mm
Probe Body Diameter	16mm
Tip Length	3mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

Note: Measurement distance from surface can be increased to 3-4mm for all Area Scan jobs.

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Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^D	Relative Permittivity ^E	Conductivity ^F (S/m)	CompF X	CompF Y	CompF Z	Alpha ^G	Depth ^H (mm)	Unc (k = 2)
150	52.3	0.79	14.08	14.08	14.08	0.00	1.00	±13.2%
450	43.5	0.97	11.90	11.90	11.90	0.16	1.20	±13.3%
750	41.9	0.89	10.26	10.26	10.26	0.00	0.80	±12.0%
835	41.5	0.90	10.00	10.00	10.00	0.43	0.80	±12.0%
1750	40.1	1.37	9.32	9.32	9.32	0.36	0.86	±12.0%
1900	40.0	1.40	8.91	8.91	8.91	0.33	0.86	±12.0%
2100	39.8	1.49	8.60	8.60	8.60	0.30	0.86	±12.0%
2200	39.5	1.67	8.44	8.44	8.44	0.33	0.90	±12.0%
2450	39.2	1.80	8.24	8.24	8.24	0.32	0.90	±12.0%
2600	39.0	1.96	7.99	7.99	7.99	0.27	0.90	±12.0%
3000	38.2	2.71	7.55	7.55	7.55	0.30	1.25	±13.1%
3600	37.9	2.91	7.45	7.45	7.45	0.30	1.35	±13.1%
3700	37.7	3.12	7.20	7.20	7.20	0.30	1.35	±13.1%
3900	37.5	3.32	6.84	6.84	6.84	0.40	1.69	±13.1%
4100	37.2	3.53	6.63	6.63	6.63	0.40	1.80	±13.1%
4200	37.1	3.65	6.39	6.39	6.39	0.40	1.70	±13.1%
4400	36.9	3.84	6.17	6.17	6.17	0.40	1.70	±13.1%
4600	36.7	4.04	6.15	6.15	6.15	0.40	1.70	±13.1%
4800	36.4	4.26	6.13	6.13	6.13	0.45	1.90	±13.1%
4900	36.3	4.40	6.07	6.07	6.07	0.40	1.80	±13.1%
5200	36.0	4.66	5.65	5.65	5.65	0.40	1.80	±13.1%
5300	35.9	4.76	5.48	5.48	5.48	0.40	1.80	±13.1%
5500	35.6	4.96	5.30	5.30	5.30	0.40	1.80	±13.1%
5900	35.5	5.07	5.14	5.14	5.14	0.40	1.80	±13.1%
5900	35.3	5.27	5.10	5.10	5.10	0.40	1.80	±13.1%

^D Frequency validity above 300 MHz at ±100 MHz only applies for CDP v4.4 and higher (see Page 5), while it is relevant to ±50 MHz. The uncertainty is the RMS of the CompF parameter in calibration frequency and the uncertainty for the relative frequency term. Frequency validity below 300 MHz is ±1%, 25, 40, 50 and 70 MHz for CompF assessments at 30, 40, 125, 150 and 200 MHz respectively. Validity of CompF assessed at 6 MHz is ±1.60 MHz, and CompF assessed at 15 MHz is 0.16 MHz. Above 300 MHz, the validity of CompF is ±10%.

^E As frequencies below 3 GHz, the validity of tissue parameters (α and σ) can be related to a 10% liquid composition formula is applied to measure S10 values. At frequencies above 3 GHz, the validity of tissue parameters (α and σ) is related to ±10%. The uncertainty is the RMS of the CompF uncertainty for incident target tissue parameters.

^F Alpha/Gamma are determined during calibration. SRFAD warns that the remaining deviation due to the uncertainty when after composition is always less than ±1% for frequencies below 3 GHz and below ±2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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Frequency Response of E-Field

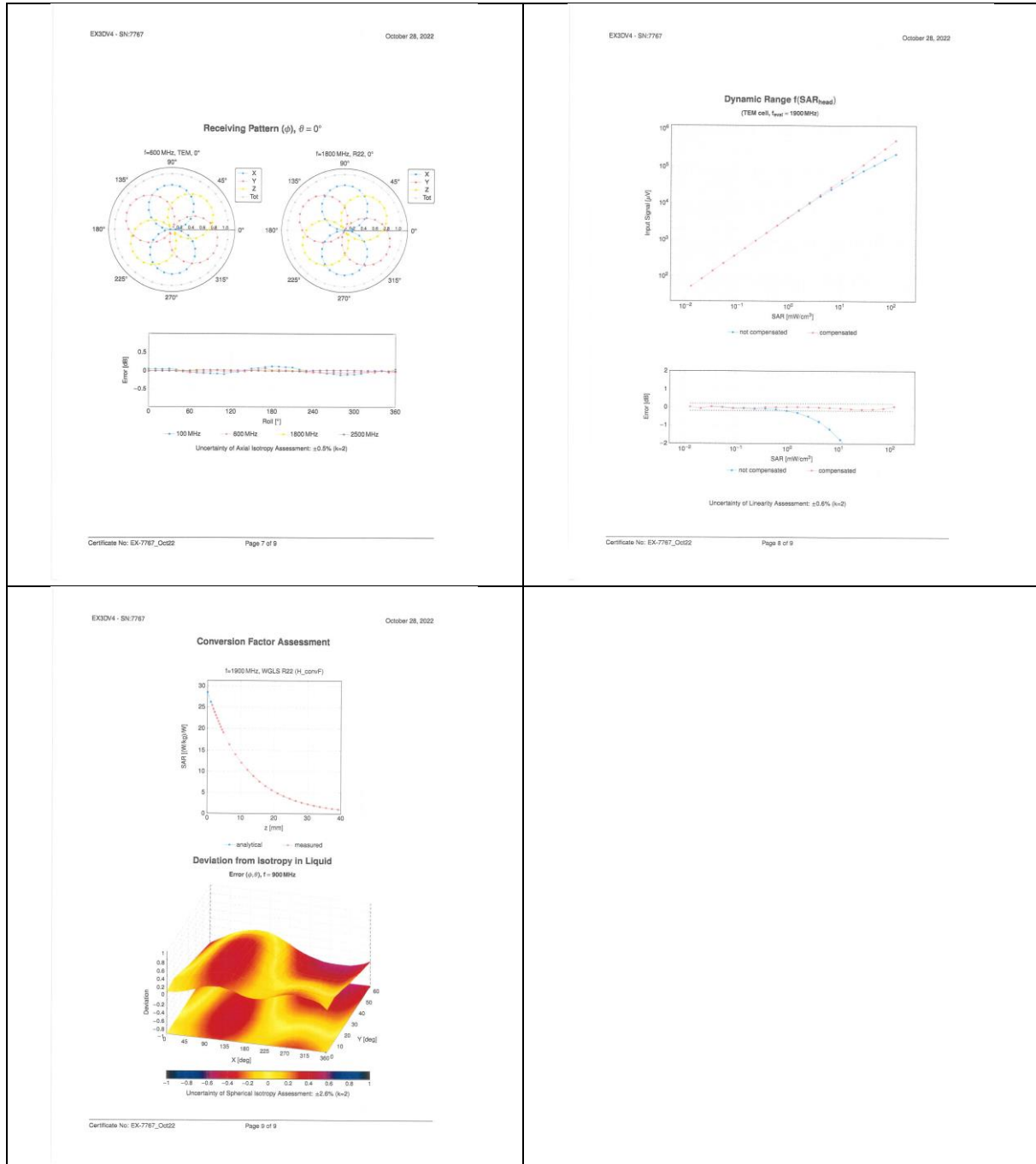
(TEM-Cell:01110 EXX, Waveguide:R22)

The graph plots the normalized frequency response of the E-field against frequency in MHz. The x-axis ranges from 200 to 3000 MHz with major ticks every 200 MHz. The y-axis ranges from 0.5 to 1.5 with major ticks every 0.1 units. Two data series are shown: TEM (red line with '+' markers) and R22 (blue line with '+' markers). Both series start at a normalized response of approximately 1.15 at 200 MHz and decrease slightly to about 1.0 at 3000 MHz. The TEM series shows a small peak around 1000 MHz. The R22 series is generally smoother than the TEM series.

Uncertainty of Frequency Response of E-Field: ±5.3% (k=2)

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4 Impedance and return loss

Dipole CLA150 SN 4025				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/4/26	-31.4	/	47.8	/
Dipole D450V3 SN 1103				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/4/21	-23	/	57.1	/



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